Journal of the International Neuropsychological Society (2002), **8**, 584–587.

DOI: 10.1017.S135561770102032X

BRIEF COMMUNICATION

The serial position effect in mild and moderately severe vascular dementia

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(RECEIVED November 20, 2000; REVISED May 4, 2001; ACCEPTED June 7, 2001)

Abstract

The present study examined the serial position effect in 2 subgroups of individuals with vascular dementia (VaD). Nineteen individuals with mild VaD and 17 individuals with moderate VaD were administered the California Verbal Learning Test. Both groups were impaired on a general memory measure, and the moderately impaired group demonstrated significantly poorer recall than the mildly impaired group on the first learning trial and on total learning across trials. In addition, individuals with mild dementia demonstrated an intact primacy and recency effect, whereas individuals with moderate dementia demonstrated neither primacy nor recency effects. The latter findings are consistent with studies examining the serial position effect in other dementia populations, and suggests that the absence of primacy and recency effects in more advanced dementia may occur regardless of dementia type. (*JINS*, 2002, *8*, 584–587.)

Keywords: Serial position effect, Vascular dementia, Memory

INTRODUCTION

Memory impairment is a core and defining feature of dementia (American Psychiatric Association, 1994). Individuals with dementia associated with vascular pathology (i.e., vascular dementia: VaD) exhibit poor retrieval of information, but relatively better recognition memory (Bowler et al., 1997; Cummings, 1994; Libon et al., 1998). This pattern of performance is purportedly associated with disruption of subcortical frontal circuits (Cummings, 1994; Roman & Royall, 1999), and is in contrast to the pattern that is typical of patients with Alzheimer's disease (AD). Individuals diagnosed with AD exhibit reduced immediate recall, rapid loss of information over time, and poor recognition memory (Bowler et al., 1997; Libon et al., 1998; Woodard et al., 1999). Memory impairment in AD is believed to reflect impaired consolidation secondary to medial temporal lobe compromise (Kohler et al., 1998; Libon et al., 1998).

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Consolidation difficulties and retrieval difficulties are associated with a different pattern of performance when tested in reference to the serial position effect (SPE). The SPE refers to better recall of items on a list learning task from the beginning (primacy) and end (recency) of the list compared to the middle of the list (Capitani et al., 1992). Difficulties with consolidation of information, as in the case of mild AD, are associated with a reduced primacy effect, but an intact recency effect. These effects are believed to reflect AD patients' limited ability to retain information presented at the beginning of the list (Bayley et al., 2000; Burkart et al., 1998; Capitani et al., 1992; Pepin & Eslinger, 1989; Spinnler et al., 1988). By contrast, difficulties with retrieval do not significantly affect either the primacy or the recency effect. Patients with frontal lobe damage and patients who had recently undergone electroconvulsive therapy (ECT) have demonstrated poor free recall of information, but intact primacy and recency effects (Bayley et al., 2000; Eslinger & Grattan, 1994).

Since memory impairment in VaD is believed to result from retrieval difficulties, and the SPE is robust to poor retrieval, individuals with VaD would be expected to dem-

onstrate intact primacy and recency effects. Whether or not this prediction is true, especially for individuals with more advanced dementia, has not been addressed. In studies of AD patients, greater disease severity is associated with a significant decrease in both primacy and recency (Pepin & Eslinger, 1989). These findings indicate that the SPE might be intact in mild but not moderate VaD. In the current study we examined the SPE in two groups of VaD subjects subdivided by performance on the Mini Mental State Exam (MMSE; Folstein et al., 1975). We predicted that individuals with mild VaD would exhibit both primacy and recency effects, while individuals with more severe VaD would demonstrate neither effect.

METHODS

Research Participants

Data from 36 participants in a 12-month, double-blind trial of citicoline for the treatment of VaD were examined in the current study. All participants met diagnostic criteria for VaD according to National Institute of Neurological Disorders and Stroke/Association Internationale pour la Recherche et l'Enseignement en Neurosciences criteria (Roman et al., 1993) and Diagnostic and Statistical Manual of Mental Disorders–IV criteria (American Psychiatric Association, 1994). Diagnosis was determined by a clinical neurologist. To be included in the drug trial, subjects were required to have a MMSE score between 9 and 24, and to be older than 54 years of age. In addition, subjects with a history of terminal illness, major psychiatric illness, or significant medical condition possibly affecting brain function were excluded. Data presented in the present study represents baseline function, prior to initiation of the study drug.

Study participants were subdivided by dementia severity based on the median split of MMSE scores. Individuals with scores greater than 21.5 were classified as mildly impaired ($n = 19$) and individuals with scores below this cutoff were classified as moderately impaired ($n = 17$). Magnetic resonance imaging (MRI) scans were evaluated by a clinical neurologist blind to group assignment to identify stroke location. All participants had evidence of subcortical hyperintensities on MRI. Six participants in the mild VaD group had evidence of one or more cortical infarctions, 7 had evidence of a basal ganglia stroke, and 2 had evidence of a thalamic stroke. In the moderately impaired group, 6 participants had evidence of cortical infarction(s), 3 had evidence of a thalamic stroke and 6 had evidence of a basal ganglia stroke. Individuals with evidence of hippocampal atrophy on MRI were excluded from the study. The mildly impaired group averaged 76.4 (4.8) years of age, 10.8 (3.2) years of education, and 23.2 (1.0) on the MMSE. The moderate–severely impaired group averaged 79.1 (6.1) years of age, 12.4 (4.6) years of education, and 16.7 (3.8) on the MMSE.

Neuropsychological Tests

All participants were administered the MMSE, Dementia Rating Scale (DRS; Mattis, 1988) and the California Verbal Learning Test (CVLT; Delis et al., 1987) as part of a larger battery of tests. Standardized administration procedures were followed for each of the measures. The dependent measure for the MMSE was the total score. The dependent measure for the DRS was the sum of the five standard subscales that comprise the total score.

The CVLT provides a variety of performance indices. We examined performance on five standard indices including immediate recall on the first trial, total recall across the five learning trials, short-delay free recall, long-delay free recall and discrimination on the recognition trial. The SPE was examined on the first learning trial of the CVLT. Each target item recalled was assigned a score of 1, and each item not recalled was assigned a score of zero. Mean scores were computed for the first two items (primacy), the last two items (recency) and the 12 middle items. For example, perfect recall of the two primacy items resulted in a score of $(1 + 1)/2 = 1.0$. As such, the maximum possible score for the primacy, recency and middle recall indices was 1.0.

Statistical Analyses

A 2 (group) $\times$ 3 (position) mixed-model ANOVA was conducted to examine the recall of items across the three positions, between the two groups. These results were followed by tests of simple effects, where the omnibus Fs were significant.

RESULTS

The two groups did not differ significantly in terms of age or education (Fs < 3). As expected, the moderately impaired group had significantly lower scores on the MMSE and DRS compared to the mildly impaired group (ps $< .01$).

The performances of both VaD groups were below the cut-off for dementia on the DRS and both groups were markedly impaired across each index of the CVLT. Comparisons between the two VaD samples revealed a significant difference on the total recall on Trial 1 and across the five learning trials, with the mildly impaired group performing better than the moderately impaired group (ps $< .01$). There were no significant group differences on the short-delay free recall, long-delay free recall, or discrimination (see Table 1).

Examination of the primacy and recency effects are illustrated in Figure 1. Results of the mixed ANOVA revealed a significant effect for position ($F = 9.19$, $p < .01$), group ($F = 10.3$, $p < .01$), and Position $\times$ Group ($F = 3.6$, $p < .05$). Follow-up analyses revealed both a primacy and a recency effect for the mildly impaired group (ps $< .05$). Individuals with MMSE greater than 21.5 exhibited significantly better recall of the first two items and the last two items compared to the middle items. There was no significant difference in recall between the first and last two items for the mildly impaired group. By contrast, the moderately

https://doi.org/10.1017/S1355617702814369 Published online by Cambridge University Press

Table 1. Performances on the DRS and the CVLT for both mild and moderately impaired VaD subjects

	Mild VaD		Moderate VaD		
Measure	*M*	(*SD*)	*M*	(*SD*)	*F*
DRS total	116.4	(11.9)	97.5	(20.6)	11.3*
Trial 1 recall	2.6	(1.3)	1.3	(1.4)	9.1*
Total recall	19.58	(5.0)	12.35	(7.3)	12.2*
Short delay free recall	1.0	(1.2)	.94	(1.6)	.01
Long delay free recall	.78	(1.1)	.76	(1.3)	.00
Discrimination	.66	(.18)	.60	(.16)	.95

*$p < .05$.

impaired group demonstrated neither a primacy nor a recency effect (*p*s $> .05$). Between group contrasts revealed significant differences on recall of the primacy and recency indices, but not on recall of the middle items.

We conducted an additional analysis to examine the SPE between two subgroups of the VaD sample using a different criterion to define group classification. Consistent with the recommendation provided by Tombaugh and McIntyre (1992), a score of 18 or higher on the MMSE was used to classify subjects as mildly impaired ($n = 26$), and a score less than 18 was used to classify subjects as more severely impaired ($n = 10$). A 2 (group) $\times$ 3 (position) mixed-model ANOVA was conducted. Results revealed significant main effects for group ($F = 8.5$, $p < .05$), position ($F = 4.1$, $p < .05$) and a trend for Group $\times$ Position ($F = 3.0$, $p = .06$). The absence of a significant interaction was probably due to the restricted sample size of the moderate–severe group.

DISCUSSION

Three important findings are evident from these preliminary results. First, individuals with mild VaD exhibited an intact SPE, recalling significantly more words from the beginning and the end of the first learning trial compared to items from the middle of the list. Second, individuals with more advanced VaD did not show preferential recall of items from either the beginning, middle or the end of the list. Third, performance on the recognition trial was markedly impaired in both groups.

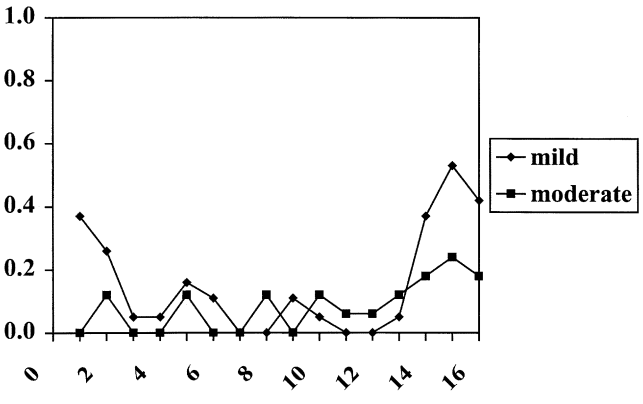

Fig. 1. Proportion of individuals recalling each of the 16 items on the first learning trial.

The first important result of the study is the observation that VaD patients with MMSE scores above 21.5 demonstrated an attenuated, but still significant SPE. Compared to the results of studies examining the SPE in healthy adults (Bayley et al., 2000), a smaller percentage of individuals with mild VaD demonstrated primacy and recency effects, however, the SPE effect remained intact in this VaD group. These results are consistent with other neurological conditions that predominately affect subcortical structures. Breen (1993) reported that both primacy and recency was intact in patients with Parkinson's disease, despite poor memory performance on standard indices of free recall. These findings are in contrast to early AD, where primacy has been found to be more severely affected (Bayley et al., 2000; Burkart et al., 1998; Capitani et al., 1992; Pepin & Eslinger, 1989; Spinnler et al., 1988), and may reflect disruption of different memory systems in these conditions. It is important to note, however, that the proportion of individuals in the mild VaD group that recalled items from the beginning of the list does not appear to be very different from the performance of the very mild AD group reported by Bayley et al. (2000). Future studies must directly compare these two groups before conclusions can be made regarding the preservation of primacy in early VaD compared to AD.

The second noteworthy finding is the absence of both the primacy and the recency effect among the more severe VaD patients. In patients with AD, the integrity of the SPE is influenced by the severity of the dementia. Individuals with very mild AD demonstrate fairly intact primacy and recency effects, whereas more impaired patients produce no primacy effect, and severely demented patients demonstrate no primacy or recency effects (Pepin & Eslinger, 1989). These findings are similar to the results of our study. Our mildly demented group demonstrated both SPEs, while the more severe group showed neither SPE. Together, these results suggest that the SPE is not retained in more severe cases of dementia, regardless of dementia type. It would be of interest to examine the SPE in the same group of individuals over time, from early in the course of the disease through more advanced stages. This would provide the opportunity to monitor change in SPE, and examine the neurocognitive and neurological correlates of reduced primacy and recency in dementia.

The performance of the two groups on the discrimination trial of the CVLT is also potentially significant. Both VaD groups in the current study exhibited poor recall of information across the five learning trials and the delayed trials of the CVLT. In addition, discrimination performance on the recognition trial was nearly as impaired as the performance of AD patients, reported in other studies (Bayley et al., 2000; Kohler et al., 1998). Since this effect was evident for the mildly impaired VaD patients, severity of dementia cannot fully account for the poor recognition performance. Two possibilities most likely explain the limited discrimination ability of the two VaD samples. First,

https://doi.org/10.1017/S1355617702814369 Published online by Cambridge University Press

retrieval may not be the only memory function that is affected in VaD. Studies have shown reduced hippocampal volume in VaD, though the magnitude of atrophy is lower than in AD (Pantel et al., 1998). The observation that some degree of structural change occurs in the hippocampus of VaD patients raises the possibility that additional memory systems (e.g., consolidation) are also affected.

A second possible explanation for the poor discrimination ability is that our groups included individuals with AD. The comorbidity of VaD and AD is high, and clinical differentiation of the two conditions is complicated (Brown et al., 2000). Long-term follow-up of individuals diagnosed with VaD have shown a high frequency of mixed dementia, or pure AD at autopsy (Nolan et al., 1998). Despite significant efforts to exclude individuals with AD in the current study, we cannot rule out the possibility that some individuals had mixed dementia. This may be especially true given the fact that both groups were largely comprised of individuals with subcortical, rather than cortical infarcts. Replicating this study with individuals with cortical infarcts and a comparison group of AD patients would be informative. In addition, because the impact of retrieval deficits on the SPE could not be directly tested in the current study, it would be of interest to examine SPE effects in patients with more restricted subcortical neuropathology (e.g., Huntington's disease) and associated retrieval difficulties compared to individuals with AD and healthy control subjects.

ACKNOWLEDGMENTS

This research was supported by a grant to Ronald Cohen, Ph.D. from Interneuron Inc.

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